```
!===============================================================================
!
! README for OMSO2e (OMI Daily L3e for OMSO2) Version 1.1.7
!
! Peter J.T. Leonard (ADNET) - 2015/02/12
!
! OMSO2e High Level Overview:
!   This is an overview of the Version 1.1.7 OMI (Ozone Monitoring Instrument)
!   OMSO2e Application Plugin Package (APP).  The OMSO2e APP creates the OMSO2e
!   data product of the U.S. OMI Science Team, which is the daily 0.25-degree
!   by 0.25-degree Level 3e (L3e) column amount SO2 product based on the
!   "best pixel" approach.  The "e" in "OMSO2e" represents "expanded".
!
!   The OMSO2e APP creates a daily L3e gridded data product file from (as many
!   as) three consecutive OMSO2G daily Level 2G (L2G) gridded data product
!   files, where each OMSO2G file contains 24 consecutive UTC hours of OMSO2
!   orbital Level 2 (L2) swath data subsetted onto a 0.25-degree by 0.25-degree
!   grid in longitude and latitude.
!
!   A L3e day is defined as the ensemble of all L2 ground pixels with pixel
!   centers that have the same local calendar date on the ground.  There are
!   two reasons behind such a definition.  First, a L3e day provides complete
!   coverage of Earth, since every point on Earth (outside of polar night)
!   experiences daylight on each calendar date (in comparison, 24 consecutive
!   UTC hours of OMI observations do not completely cover Earth).  Second, the
!   L3e day puts the discontinuity (i.e., where the L2 observations within a
!   given day differ by almost 24 hours) at +/-180 degrees longitude, and, thus,
!   the discontinuity can be placed undistractingly along the extreme left and
!   right edges of several commonly used map projections.
!
!   The calendar date of the L3e day is the calendar date at Greenwich midway
!   through the L3e day, and is specified via the L3e day of year parameter in
!   the PCF (Process Control File) of the OMSO2e APP.  Note that some of the
!   L2 observations at the beginning of a L3e day will correspond to the
!   previous calendar date at Greenwich, and some of the L2 observations at
!   the end of a L3e day will correspond to the next calendar date at Greenwich.
!   Consequently, data from three consecutive OMI L2G files are required to
!   fully populate the L3e grid at all longitudes for any given L3e day.
!
!   The OMSO2e APP was developed for Dr. Nick Krotkov (NASA/GSFC), and is based
!   upon the TOMS Level 3 Gridded Software.  The latter was developed over a
!   period of many years by several people:  W. Byerly, D. Cao, E. Celarier,
!   Q. Choung, S. Huang, B. Irby, D. Lee, L. Liu, L. Moy, M. Peng, L. Phung,
!   B. Raines, C. Seftor, and, especially, C. Wellemeyer.
!
! Adopted OMSO2e Grid:
!   The adopted L3e grid is a 0.25-degree by 0.25-degree grid in longitude and
!   latitude.  The dimensions of the grid are 1440 by 720.  The center of the
!   first grid cell is located at longitude -179.875 and latitude -89.875.  The
!   center of the final grid cell is located at longitude 179.875 and latitude
!   89.875.  The center of the grid itself is located at longitude 0.0 and
!   latitude 0.0, and corresponds to the corners of four grid cells.
!
!   The grid format of the OMSO2e HDF-EOS 5 product files is consistent with
!   KNMI document number SD-OMIE-KNMI-443 entitled "Definition of OMI Grids
!   for Level 3 and Level 4 Data Products" by J.P. Veefkind, J.F. De Hahn,
!   P.F. Levelt and R. Noordhoek.
!
!   The format of the OMSO2e HDF-EOS 5 product files is consistent with "A File
!   Format for Satellite Atmospheric Chemistry Data Based On Aura File Format
!   Guidelines" by C. Craig, P. Veefkind, P. Leonard, P. Wagner, C. Vuu and
!   D. Shepard.
!
! OMSO2e Gridding Algorithm:
!   Each grid cell in the L3e product contains the data for the L2 observation
!   that overlaps with the L3e grid cell which has the shortest path length
```

```
[path length = 1/cos(solar zenith angle) + 1/cos(viewing zenith angle)].

The overlap between an L2 observation and an L3e grid cell is determined
in a manner consistent with the document entitled "Total Ozone Mapping
Spectrometer (TOMS) Level-3 Data Products User's Guide" by R. McPeters,
P.K. Bhartia, A. Kruger, et al.

An L2 observation can be mapped onto more than one L3e grid cell, if the
L2 observation overlaps with and has the shortest path length for more
than one L3e grid cell.

The L2 observations are not averaged or weighted in any way in the L3e
product.

The L3e product currently excludes L2 data collected in OMI spatial and
spectral zoom modes.

Before the L2 observation with the shortest path length is selected, each
of the L2 observations that overlap with each L3e grid cell is considered,
and compared with several exclusion criteria.  These criteria are summarized
here in sequence.

Let l3_tnoon be the time at noon UTC for the L3e day, and let l2g_time
be the L2 observation time.

A1) As a rough first cut, L2 observations made outside of the 48-hour time
    interval centered at l3_tnoon are excluded.  Thus, L2 observations with

    l2g_time <  l3_tnoon - (24 hours - 15 minutes)

    or

    l2g_time >= l3_tnoon + (24 hours - 15 minutes)

    are excluded.

At any given moment, all points on Earth between the longitude of midnight
and the dateline that are on the same side of the dateline have the same
calendar date.  The calendar dates on opposite sides of the dateline differ
by one day, except at the instant when the longitude of midnight and the
dateline coincide, in which case the date is the same everywhere on Earth.

Let l2_lom be the longitude of midnight at l2g_time, and let l2g_lon be the
longitude at the center of the L2 observation.  The dateline is assumed to
lie strictly at a longitude of +/-180 degrees for the sake of simplicity,
which ignores the zigs and zags of the actual dateline.

A2) L2 observations with local calendar dates on the ground that correspond
    to the day before the L3e day are excluded.  This has been
    implemented as L2 observations with

    l2g_time <  l3_tnoon - 15 minutes

    and

    -180 degrees <= l2g_lon < l2_lom

    are excluded.

A3) L2 observations with local calendar dates on the ground that correspond
    to the day after the L3e day are excluded.  This has been
    implemented as L2 observations with

    l2g_time >= l3_tnoon + 15 minutes

    and
```

```
!         l2_lom <= l2g_lon < 180 degrees
!
!         are excluded.
!
!    Let bit5 be "bit 5" (the 6th bit) of the "ground pixel quality flag" of the
!    L2 observation.  This is the solar eclipse possibility flag.
!
!    A4) L2 observations with the solar eclipse possibility flag set are
!         excluded.  Thus, L2 observations with
!
!         bit5 /= 0
!
!         are excluded.
!
!    Let bit11 be "bit 11" (the 12th bit) of the "quality flags" of the L2
!    observation.  This is the row anomaly flag.
!
!    A5) L2 observations with the row anomaly flag set are excluded.  Thus, L2
!         observations with
!
!         bit11 /= 0
!
!         are excluded.
!
! OMSO2e Gridding Algorithm for PBL SO2:
!    There are several criteria in addition to A1 through A5 (above) for
!    excluding L2 observations from the L3e grid for the PBL observations.
!
!    C6) L2 observations with a radiative cloud fraction greater than 0.2 or less
!         than 0.0 are excluded.  Thus, L2 observations with
!
!         l2g_rcf > 0.2
!
!         or
!
!         l2g_rcf < 0.0
!
!         are excluded
!
!    C7) L2 observations with a solar zenith angle greater than 70.0 degrees are
!         excluded.  Thus, L2 observations with
!
!         l2g_sza > 70.0
!
!         are excluded.
!
!    C8) L2 observations with a 1-based scene number (cross-track position number)
!         greater than 58 or less than 3 are excluded.  Thus, L2 observations with
!
!         l2g_scene > 58
!
!         or
!
!         l2g_scene < 3
!
!         are excluded (i.e. included scenes must satisfy  2 < l2g_scene < 59)
!
!    C9) No L2 observations are excluded based on terrain height in Version 1.1.7
!         of the OMSO2e APP.
!
! OMSO2e Adjustment for PBL SO2:
!
!    C10) A Pacific Sector Correction (PSC) is not applied in Version 1.1.7 of
!          the OMSO2e APP, and the PacificSectorCorrection diagnostic field has
!          been replaced by the PacificSectorAverage diagnostic field.
```

```
!
!    The PBL SO2 is scaled by the clear sky (globally fixed) Air Mass Factor
!    (AMF).  This step also generates a new L3e data field, SlantColumnAmountSO2,
!    which is the original PBL SO2 column amount multiplied by a factor of 0.36.
!    The "new" PBL SO2 column amount is then computed from the slant column
!    amount SO2 and the local monthly AMF from the GEOS-CHEM model.
!
!    C11) Let l3_caspbl be the column amount SO2 PBL.  The slant column amount
!         SO2 for each grid cell, l3_scaso2, is simply
!
!         l3_scaso2 = l3_caspbl * 0.36
!
!    C12) Let l3_amfclr be the empirical mean clear sky AMF for the month of
!         observation (derived using the approach described in "Retrieval of
!         vertical columns of sulfur dioxide from SCIAMACHY and OMI: Air mass
!         factor algorithm development, validation, and error analysis" by
!         C. Lee, R. V. Martin, A. van Donkelaar, et al.), and let l3_scaso2 be
!         the slant column amount SO2.  The scaled PBL SO2 is then
!
!         l3_caspbl = l3_scaso2 / l3_amfclr
!
!         The result (of C11 and C12) is equivalent to
!
!         l3_caspbl = l3_caspbl * 0.36 / l3_amfclr
!
! South Atlantic Anomaly Mask for PBL SO2:
!
!    C13) Finally, the PBL and slant column SO2 are set to fill values in grid
!         cells that fall within the South Atlantic Anomaly (i.e. SAA) region.
!
!         A smaller SAA mask has been implemented in Version 1.1.7 of the OMSO2e
!         APP.  The new mask has been empirically derived from monthly maps of
!         the PBL SO2 column amount for June and July 2005, and covers the very
!         noisiest parts of the SAA.
!
!===============================================================================
```